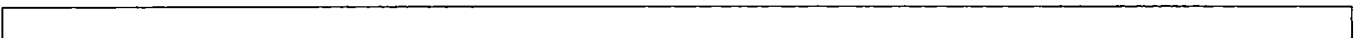


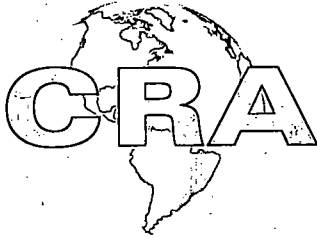
INTERIM EVALUATION OF REMEDIAL ACTION

**SUMMIT NATIONAL SUPERFUND SITE
DEERFIELD, OHIO**

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DEERFIELD, OHIO**

MARCH 1999

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1.0 INTRODUCTION

1.1 PURPOSE AND LAYOUT OF REPORT

The purpose of this interim evaluation is to summarize the results of the first 4 years of implementation of the remedial action (RA) at the Summit National Superfund Site (Site) in Deerfield, Ohio, and to assess whether the RA is meeting the objectives for remediation of the Site. This interim evaluation also evaluates alternate RA options and their applicability to enhancing the RA at the Site, and presents a proposed alternate RA to be implemented at the Site. This interim evaluation is organized as follows:

- Section 1.0 presents the purpose of the report, and a summary of the Site history, remedy selected for the Site, monitoring activities for the Site, and the layout of the report;
- Section 2.0 presents a summary of the results of the first 4 years of implementation of the remedy;
- Section 3.0 presents an evaluation of alternate remedial actions and their applicability to enhancing the RA at the Site;
- Section 4.0 presents an alternate RA recommended for the Site;
- Section 5.0 presents a proposed scope of work for the recommended alternate RA; and
- Section 6.0 presents a proposed implementation schedule for the recommended alternate RA.

1.2 SITE HISTORY

1.2.1 PREVIOUS SITE USE

The Site initially was operated as a coal strip-mine, and included a coal wash pond and stockpile. A hazardous waste incinerator then was installed, permitted, and operated at the Site from April 1974 to June 1978. The Site also was used as a hazardous waste recycling, storage, and disposal facility during the 1974 to 1978 time period. Based on complaints received from local residents and investigations by the Ohio Environmental Protection Agency (OEPA), the facility ceased operation on June 12, 1978.

1.2.2 INTERIM RESPONSE ACTIONS

OEPA fenced the Site, installed monitoring wells, graded the Site for drainage, and identified and staged on-Site drums in 1980. The United States Environmental Protection Agency (USEPA) organized a cleanup of surficial wastes commencing in 1980, which was funded by eight Site generators. The surficial cleanup, including drum removal, was completed in 1982. Based on initial Site investigations by USEPA, the Site was put on the National Priorities List in 1983.

1.2.3 REMEDIAL INVESTIGATIONS

The remedial investigation (RI) was performed in two phases in 1984 and 1985/86 by CH₂M Hill. The final RI Report dated February 10, 1988 was prepared by CH₂M Hill for USEPA. CH₂M Hill also prepared the Feasibility Study Report dated February 12, 1988 for USEPA. The Record of Decision (ROD) was signed on June 30, 1988 by USEPA.

1.2.4 CONSENT DECREE/STATEMENT OF WORK

The final negotiated remedy is documented in the Statement of Work attached to the Consent Decree, and is summarized in Section 1.3. The negotiation of the Consent Decree and Statement of Work (SOW) between the Potentially Responsible Parties (PRPs) and USEPA and OEPA was completed in 1989, and became effective on June 11, 1991.

1.2.5 REMEDIAL DESIGN

The remedial design and pre-design investigations were performed by CRA on behalf of SNFT, commencing June 11, 1991. The Final Design Report was approved by USEPA and OEPA on June 22, 1993.

1.2.6 REMEDIAL CONSTRUCTION

Remedial construction (RC) activities commenced at the Site on July 22, 1993, and were completed on August 4, 1995.

1.2.7 OPERATION, MAINTENANCE, AND MONITORING

Operation, maintenance, and monitoring (OM&M) of the groundwater treatment system commenced on May 19, 1994 (for Site dewatering activities required during remedial construction), the groundwater extraction system on September 9, 1994, and the Site as a whole on August 5, 1995.

1.3 REMEDY SELECTED FOR THE SITE

The remedy selected for the Site was implemented in five phases, and consisted of the following components:

- i) Phase 1 - Groundwater Treatment System (GWTS);
- ii) Phase 2 - Groundwater Extraction System (GWES);
- iii) Phase 3 - Soil Removal and Treatment;
- iv) Phase 4 - Final Site Cover; and
- v) Phase 5 - Well Installation and Abandonment.

In addition to the five phases of remediation, early excavation and on-Site stockpiling of off-Site sediments from the south drainage ditch and impoundment were completed as an interim response action in October 1991, since the unusual dry conditions allowed excavation of the sediments without the need to dewater the south impoundment.

The remedial activities included in each of the five phases of the remedial construction are as follows:

- i) Phase 1 - Groundwater Treatment System:
 - Environmental Construction Inc. commenced on July 22, 1993,
 - clearing and grubbing,
 - coal tipple demolition,
 - decontamination facility,
 - drum relocation,
 - relocation of sediment and rubble stockpiles,
 - placement of clean fill material in the GWTS work area,
 - pile installation to support the treatment plant,

- construction of reinforced concrete foundations and floor slabs,
- installation of treatment equipment (caustic tank, equalization/aeration tank, inclined plate settler, biotower, sand filter, granular activated carbon adsorbers, and sludge dewatering unit), and
- completed on May 16, 1994 (37 days ahead of the RC Schedule);

ii) Phase 2 - Groundwater Extraction System:

- Severson Environmental Services commenced on March 24, 1994,
- relocated south drainage ditch and perimeter fence,
- removal of pond sediments and off-Site contaminated soils and transfer to soil staging area,
- placement of 2 feet of clean common fill in off-Site contaminated soil removal areas,
- demolition of Watson house,
- pregrading of pipe and media drain alignment,
- excavation for and installation of wet well, manholes, and pipe and media drain,
- installation of compressed air forcemain, extracted groundwater forcemain, and power and control conduits,
- placement of 2 feet of clean final soil cover in the GWES work area,
- construction of on-Site gravel maintenance road and riprap lined east drainage ditch,
- construction of extraction well chambers,
- installation of mechanical and electrical components,
- commissioning of groundwater extraction and treatment systems, and
- completed on December 1, 1994 (3 weeks ahead of the RC Schedule);

iii) Phase 3 - Soil Removal and Treatment:

- Severson Environmental Services commenced on April 29, 1994,
- operation and maintenance of a soil staging area, drum staging area, and personal decontamination area,
- installation and operation of a mobile incinerator,
- incinerator performance demonstration burn reporting,
- air modeling and monitoring to determine compliance of incinerator emissions,
- demolition of existing structures and objects,

- removal, dismantling, and on-Site disposal of underground storage tanks, and on-Site and/or off-Site treatment of tank contents,
 - excavation, overpacking, sampling, fingerprinting, characterization, waste handling, preparation, and off-Site treatment/disposal of buried drums/containers and contents,
 - excavation and on-Site incineration of upper 2 feet of soil from designated grids,
 - regrading Site to base of final Site cover,
 - placement of first 6 inches of final Site cover, and
 - completed on April 3, 1995 (15 months ahead of the RC Schedule);
- iv) Phase 4 - Final Site Cover:
- D&M Construction Co. commenced on June 1, 1995,
 - imported and placed 18 inches of clean permeable sandy loam and 6 inches of clean topsoil as the final Site cover,
 - establishment of a vegetative cover, and
 - completed on August 4, 1995 (16 months ahead of the RC Schedule); and
- v) Phase 5 - Well Installation and Abandonment:
- Frontz Drilling Inc. commenced on July 22, 1993,
 - installation of potable well,
 - installation of new monitoring wells and piezometers (both on and off Site),
 - abandonment of existing monitoring wells and piezometers,
 - installation of extraction wells,
 - adjustment of existing monitoring wells and piezometers to remain, and
 - completed on November 4, 1994 (3 weeks ahead of the RC Schedule).

On completion of the RA construction activities, CRA prepared a final RA construction report documenting the RA construction activities completed at the Site, and the construction quality assurance activities and testing performed during implementation of the RA construction activities. The RA construction activities were completed 16 months ahead of the USEPA and OEPA approved remedial construction schedule.

1.4 SUMMARY OF MONITORING ACTIVITIES

CRA presently serves as the engineering consultant to SNFT for the OM&M of the Site, including conducting and reporting the semi-annual groundwater monitoring activities, and preparing the annual evaluation and progress reports for submission to USEPA and OEPA. A summary of the Site monitoring requirements is presented in the following subsections.

1.4.1 TREATMENT PLANT MONITORING

As required by the OM&M Plan, treatment plant monitoring consists of monthly groundwater influent and treated water effluent sampling and analyses, and recording of daily flow rates. The results are submitted to USEPA and OEPA on a monthly basis. This monitoring is performed by CRA Services, the OM&M contractor retained by SNFT to provide the OM&M services. A summary and evaluation of the treatment plant influent monitoring analytical data is presented in Section 2.0.

1.4.2 GROUNDWATER MONITORING

As required by the OM&M Plan, groundwater quality monitoring is to be performed at startup, and twice a year for the first 5 years of operation of the groundwater extraction system at the Site, and annually thereafter until termination criteria have been met [which is not expected to be within the 30-year time frame considered in the National Contingency Plan (NCP)]. Also as required by the OM&M Plan, groundwater hydraulic monitoring is to be performed monthly for the first year of operation, and then quarterly until termination of the groundwater extraction system. This monitoring is performed by CRA on behalf of SNFT.

For the first three rounds of groundwater quality monitoring, the groundwater samples were analyzed for the full target compound list/target analyte list (TCL/TAL) of parameters. A Site-specific indicator parameter list (SSIPL) then was developed and approved by USEPA and OEPA. All further groundwater samples are to be analyzed for the SSIPL, except for every fifth year of sampling when the full TCL/TAL parameters are to be analyzed for.

Groundwater monitoring reports are submitted to USEPA and OEPA for each monitoring event. A summary and evaluation of the groundwater monitoring data is presented in Section 2.0.

2.0 RESULTS OF IMPLEMENTATION OF SELECTED REMEDY

2.1 1995 EVALUATION

An April 1995 evaluation of the Water Table Unit (WTU) GWES (pipe and media drain) confirmed that the WTU extraction system was effectively providing hydraulic containment of the WTU groundwater at the Site boundary. The volume of groundwater extracted and treated at the on-Site GWTS [approximately 20 gallons per minute (gpm) from the pipe and media drain] was less than the predicted flow rate from the pipe and media drain of 36 gpm.

The Intermediate Unit (IU) GWES (six bedrock extraction wells) was extracting groundwater at a combined rate of less than 2.5 gpm, which was significantly less than the predicted combined IU GWES extraction rate of 6 gpm. Based on a review of the IU groundwater contours, it was determined that the extraction wells were causing a downward hydraulic gradient from the WTU to the IU.

Based on the potential for the extraction wells to cause contaminated groundwater to move downward from the WTU to the IU, CRA recommended that the extraction wells be shut down and sealed. USEPA and OEPA subsequently concurred with this recommendation. The extraction wells were shut down in May 1995 and abandoned in June 1995, and additional IU monitoring wells were installed as recommended by CRA and approved by USEPA and OEPA.

In conjunction with the shut down of the bedrock extraction wells, CRA reviewed the Upper Sharon Unit (USU) groundwater monitoring network for the Site. Due to the lack of data north of the Site and the conflicting historical flow directions in the USU, CRA recommended the installation of three additional USU monitoring wells. CRA also recommended an existing on-Site monitoring well (MW25) potentially screened in both the upper IU (UIU) and lower IU (LIU) be abandoned and replaced by a new LIU monitoring well. These modifications to the groundwater monitoring network were approved by USEPA and OEPA, and were implemented in June 1995.

2.2 1998 EVALUATION

Based on the groundwater monitoring reports submitted to USEPA and OEPA from 1995 to 1998, the WTU extraction system continues to effectively provide hydraulic containment of the WTU groundwater at the Site boundary. The volume of groundwater extracted and treated at the on-Site GWTS (approximately 20 gpm from

the pipe and media drain) continues to be less than the predicted flow rate from the pipe and media drain of 36 gpm. Groundwater quality monitoring to date has indicated no off-Site migration of Site-related contaminants in the groundwater, and little change in the groundwater quality, both on and off Site. Site-related VOCs were detected above background levels at select UIU and LIU monitoring wells during the groundwater quality monitoring conducted from 1995 to 1998.

Review of the GWTS influent analytical results indicates the VOC and SVOC influent chemistry is not increasing as predicted in the Final Design Report. Table 1 provides a summary comparison of the design influent VOC concentrations with the actual influent VOC concentrations over the last 4 years of operation of the groundwater extraction and treatment systems. As can be seen from Table 1, the VOC loading to the groundwater treatment system has remained relatively constant, with no indication of increasing VOC concentrations since startup of the groundwater extraction system in 1994. Furthermore, at time $t=2.7$ years (or July 1997) after commencement of groundwater extraction, it was anticipated it would be necessary to commence operation of the biotower to provide the primary treatment for acetone and methyl ethyl ketone (MEK) in the extracted groundwater. It is apparent from the influent chemistry to the GWTS that there is no requirement at this stage, or in the foreseeable future, to commence operation of the biotower as both acetone and MEK still have not been detected in the influent to the treatment plant.

Evaluation of the current chemical profile of collected groundwater samples from the on-Site groundwater monitoring wells confirms that the primary zone of groundwater contamination and principal contaminants have remained consistent since startup of the GWES in 1994, and even since the initial groundwater monitoring conducted during the RI in 1984 and 1986. The lower than anticipated chemical loading to the pipe and media drain is considered due to one or both of the following phenomena:

- i) contaminated groundwater beneath the Site is not moving, and therefore groundwater with elevated concentrations is not being drawn to the pipe and media drain; and/or
- ii) the contribution of contaminated groundwater from the Site side of the pipe and media drain is negligible compared to the relatively clean groundwater contribution from the off-Site side of the pipe and media drain.

The following points summarize the results of implementation of the selected remedy from startup of the groundwater treatment plant in May 1994 to the present:

- the GWES is effectively providing hydraulic containment of groundwater in the WTU at the Site boundary;
- operation of the GWES continues to provide an upward hydraulic gradient from the UIU to the WTU along the southern Site boundary and sections of the eastern and western Site boundaries;
- no off-Site groundwater contaminant migration is occurring based on the semi-annual groundwater quality monitoring performed since startup of the GWES;
- the GWTS is effectively treating the extracted groundwater in compliance with the OEPA May 18, 1994 Substantive Permit for the Site, although iron, which is not a Site-related contaminant, is the primary constituent being treated;
- elevated concentrations of VOCs and SVOCs have not been detected in the influent to the GWTS, indicating a much lower contaminant migration rate in the WTU than expected;
- the aeration/equalization tank in the GWTS is capable of effectively removing the low level VOCs from the extracted groundwater to below the OEPA allowable discharge concentrations. Therefore, the aqueous carbon treatment is not required for VOC removal at this time; and
- the iron concentrations in the influent groundwater [on the order of 50,000 micrograms per litre ($\mu\text{g/L}$)] (see Table 1) are below the background concentrations of iron in the groundwater (on the order of 100,000 $\mu\text{g/L}$). The OEPA May 1994 Substantive Permit discharge criterion for iron is 1,000 $\mu\text{g/L}$. Therefore, the GWTS primarily is being operated to remove iron, which is a background parameter in groundwater in the area and not related to previous waste disposal activities at the Site.

3.0 ALTERNATIVE REMEDIAL ACTIONS

As stated in the RI Report, barium, chromium, and select VOCs and SVOCs are the only Site-related contaminants in groundwater attributed to previous waste disposal activities at the Site. Review of the GWTS influent analytical results (see Section 2.0) indicates that the VOC and SVOC influent chemistry is not increasing as predicted in the Final Design Report.

As stated in the Final Design Report, removal of inorganic compounds from the influent water stream would be required prior to biological treatment for VOCs in the biotower. Consequently, the treatment system process components for removal of inorganic compounds were incorporated into the remedial design to allow for efficient treatment in the biotower of the anticipated Site-related VOC contaminants in the influent stream to the groundwater treatment system. As the biotower has not been required since startup of groundwater extraction, nor does it appear to be required in the foreseeable future, the GWTS is essentially treating the extracted groundwater for low level VOCs and iron. Considering the continued low concentrations of Site-related VOC contaminants in the influent stream to the groundwater treatment system, and the significant effort being maintained to treat the extracted groundwater essentially for iron, which is not related to previous disposal activities the applicability of implementation of several alternate remedial actions to the cleanup at the Site have been evaluated and are presented below.

3.1 SOIL FLUSHING

Soil flushing is the process of increasing the circulation of water through the affected soils. Some of the contamination present (above or below the water table) dissolves into the water moving through the soils and travels towards the collection system. Increasing the rate of groundwater travel and decreasing the distance groundwater must travel to reach a collection point, increases the rate of contaminant removal.

A conceptual soil-flushing system would consist of enhanced groundwater collection and re-infiltration of treated water. The combination of these two components would serve to increase the rate of water circulation (i.e., soil-flushing) both above and below the water table, maintain the complete hydraulic containment of the Site, and prevent zones of groundwater stagnation.

The existing pipe and media drain would be expanded by installing a series of approximately five shallow north-south trending media drains to collect groundwater

which then would flow along the drains and discharge into the existing pipe and media drain. These drains would serve to decrease the distance that water and contaminants must flow to reach a collection point, thereby reducing the flushing time.

The infiltration system would consist of a series of approximately six infiltration media trenches. Treated groundwater would be discharged from the treatment plant through a header pipe to the infiltration trenches, and flood the infiltration trenches. The water infiltrating from the trenches would flush the soils and increase the rate of groundwater flow (i.e., the hydraulic gradient) to the collection drains. The increased hydraulic gradient would act to increase the effective gradient moving contaminated groundwater to the collection drains.

The rate at which water can be effectively circulated through the Site is severely limited by the low permeability and heterogeneous nature of the fill material. Even under highly optimistic scenarios, the average rate of groundwater flow through the areas of clayey silt to silty clay overburden materials encountered at the Site is unlikely to exceed several inches per year. Due to the limited ability to increase the hydraulic gradient, the maximum increase in the rate of groundwater flow that can be achieved by an aggressive soil-flushing scheme is approximately 100 percent (i.e., double the rate). Given the retardation of the contaminants (i.e., dissolved contaminants travel more slowly than groundwater flow), the distance water must flow to a collection point (minimum of tens of feet), and the many flushings required to reduce contaminant concentrations to acceptable levels, cleanup times are likely to remain on the order of hundreds to thousands of years under any feasible soil-flushing scenario. Therefore, soil flushing is not considered to be an enhancement to the existing RA.

3.2 ENHANCED BIOLOGICAL REMEDIATION

Enhanced biological remediation consists of enhancing the biological degradation of contaminants in the subsurface. This is typically achieved by introducing one or more of: nutrients, oxygen, and bacteria. This method can be used both above and below the water table. The effectiveness of this method is expected to be severely limited by the low permeability nature of the overburden material at the Site. The low permeability reduces the ability to supply the additives to the contaminated areas, and therefore, the implementation of enhanced biological remediation likely would require the construction of a water circulation system similar to a soil flushing system in order to circulate the additives through the soil. Furthermore, significant efforts would be required to maintain anaerobic conditions to prevent reductive dechlorination reactions.

Therefore, enhanced biological remediation is not considered to be an enhancement to the existing RA.

3.3 SOIL VAPOR EXTRACTION

Soil vapor extraction (SVE) is a process whereby air is circulated through the subsurface similar to soil-flushing. VOCs will tend to volatilize (evaporate) into the air and be carried to a collection point. This process can only be effective for volatile compounds and will have little to no effect on semi-volatile compounds or metals. A SVE system would require installation and operation of: wells and/or trenches for the collection and possibly injection of air, a header system for air circulation, a blower, and possibly an air treatment system. An enhancement of the current groundwater collection system might also be required to further dewater the overburden, thereby increasing the effective zone for SVE. The effectiveness of a SVE system would be severely limited by the low permeability of the overburden soils and the high moisture content above the water table would limit the rate of air circulation and the proportion of air present in the soil. Therefore, SVE is not considered to be an enhancement to the existing RA.

3.4 REVISED DISCHARGE PERMIT

Increased discharge limits for the inorganic compounds in the extracted groundwater, and iron in particular, would reduce the groundwater treatment requirements to meet the May 18, 1994 OEPA Substantive Permit. Removal of iron from the extracted groundwater to less than 1,000 µg/L (OEPA Substantive Permit requirement) is the existing primary treatment requirement, as the concentrations of organic compounds in the extracted groundwater still are very low. Iron was not identified in the RI as a contaminant related to previous waste disposal activities at the Site.

The treatment processes in operation to remove the iron from the extracted groundwater are caustic addition, clarification, and sand filtration. In addition, the majority of sludge presently generated is related to removal of iron from the extracted groundwater. Deleting the iron removal requirement would eliminate the caustic addition, allow the clarifier and sand filter to be bypassed, and significantly reduce the sludge handling and disposal requirements also resulting in a reduced operator man-hour requirement to operate and maintain the treatment system. In order not to plug the aqueous carbon that would remain as the contingency treatment process for the VOCs, a biodegradable sequestering agent would be introduced into the groundwater flow. The sequestering agent keeps the inorganic compounds in a dissolved state in the groundwater, thus

facilitating minimal deposition into the piping and the discharge ditch. Since the high concentrations of inorganic compounds, and specifically iron, are not Site-related contaminants, and since the concentration of iron in the influent groundwater is less than the area background concentration of iron in groundwater CRA recommends that SNFT petition OEPA to remove discharge criteria for the inorganic parameters from the OEPA Substantive Permit if groundwater treatment is retained as a remedial component at the Site.

3.5 PHYTOREMEDIATION

Phytoremediation is an on-site, in situ bioremediation technique that involves the use of vegetation to remediate or stabilize soils, sludges, sediments, wastewater, or groundwater contaminated with organic and/or inorganic pollutants. It can be performed for either terrestrial or aquatic systems and, for the latter, can even involve hydroponics.

Phytoremediation can supplement and accelerate natural attenuation to increase the effectiveness of natural attenuation. This may involve adding cometabolites, nutrients, electron donors/receivers, carbon sources, etc., to the soils around the site's vegetation, and/or increasing the density or types of vegetation present.

Phytoremediation caps may be considered to target underground accumulations of contaminants. Phytoremediation barriers (copses of trees with high hydraulic requirements) may be planted to stop/inhibit groundwater flow, and clean up contaminants in the groundwater.

The implementation of phytoremediation may consist of the following activities:

- i) planting of trees on Site;
- ii) performance of a phased shutdown of the groundwater extraction and treatment systems as the phytoremediation processes become established;
- iii) maintenance and monitoring of the phytoremediation processes; and
- iv) continued groundwater monitoring at the Site.

Phytoremediation is considered to be an alternate remedial action to the current groundwater extraction system. The phytoremediation would reduce the amount of infiltration at the Site, thereby decreasing recharge to the WTU groundwater beneath the Site, and thereby reducing further the already low to non-existent rate of groundwater

flow from the Site. CRA recommends that phytoremediation be considered as an alternate to the current groundwater extraction system.

3.6 ENGINEERED WETLANDS TREATMENT

The implementation of engineered wetlands treatment at the Site would consist of the following activities:

- i) construction of an engineered wetland treatment system at the Site;
- ii) performance of a phased shutdown of the GWTS as the wetlands processes become established;
- iii) preparation of the GWTS for "idle" storage;
- iv) maintenance and monitoring of the wetlands treatment processes; and
- v) continued groundwater monitoring at the Site.

Wetlands engineering can be used to treat stormwater runoff, surface streams, and even extracted groundwater using existing natural wetlands, either as is or after some degree of re-engineering, and by the use of constructed wetlands specifically designed and placed to treat the water.

Constructed wetlands usually consist of a number of individual rectangular cells filled with wetland vegetation and connected in series or parallel in one or more trains. Cells are surrounded by earthen berms and contain structures (distributors, weirs, piping) to ensure good hydraulic dispersion, control, and collection. Additional open water areas, integral ponds, and forebays may or may not be involved, depending on the type and application. With constructed wetlands, hydrological conditions, vegetation specifically chosen for effectiveness with certain pollutants, and soil substrates engineered for various purposes can be selected to design a system which is highly effective for water treatment. Both free water surface (FWS, marsh type) and subsurface flow (SSF, sometimes called reed bed flow) constructed wetlands can be used.

When wetlands engineering is being carried out, appropriate wetland vegetation has to be utilized/established and grown/enhanced. Biodiverse mixtures of native plant materials are commonly used, and the vegetated cells may provide habitat and aesthetic values as well as treatment.

Treatment wetlands are effective in reducing nutrients, pathogens (bacteria, viruses), organic compounds, biological oxygen demand (BOD), and suspended solids in

wastewaters by a variety of biological, chemical and physical methods. Due to the presence of naturally-occurring organics in wetlands, most oil and grease, phenols, many pesticides, herbicides, and other organic compounds are broken down in a wetland by microbes and plants and reduced to negligible levels.

An engineered groundwater treatment wetland system could be used to replace the mechanical GWTS to treat the Site-related contaminants in extracted groundwater, since the current groundwater contaminant levels are at or near the OEPA discharge requirements. However, the high iron concentrations, which are not a Site-related contaminant, would limit the effectiveness of an engineered wetland, and a pretreatment system to remove these compounds would be required. Therefore, engineered wetlands are not considered to be an enhancement to the existing RA.

3.7 MONITORED NATURAL ATTENUATION

Natural attenuation is the term used to refer to all of the naturally occurring processes that control the fate of contaminants in soil and groundwater, and the recognition that these processes can act to naturally contain and remediate such contamination. The term natural attenuation predominantly has come into use to describe all natural processes that serve to reduce the mass and/or concentration of contaminants in the subsurface. The term monitored natural attenuation (MNA) more recently has been applied by USEPA to describe the reliance of natural attenuation processes to achieve remedial objectives, and the continued monitoring of the progress of natural attenuation processes to ensure long-term effectiveness and protectiveness of the remedy. In addition to natural attenuation, terms such as intrinsic remediation, intrinsic bioremediation, passive bioremediation, natural recovery, natural assimilation, and natural biodegradation all have been applied to describe the reduction in contaminants in the subsurface resulting from naturally occurring processes.

Natural attenuation processes are classified as destructive and non-destructive. Destructive natural attenuation processes result in a reduction in contaminant mass. Destructive natural attenuation processes consist of biological degradation (where naturally occurring microorganisms indigenous to the subsurface breakdown, or degrade, contaminant compounds into less toxic or nontoxic compounds), and chemical degradation (where contaminants chemically break down, or degrade into less toxic or nontoxic compounds). Non-destructive natural attenuation processes result in a reduction in contaminant concentrations. Non-destructive natural attenuation processes consist of advection (contaminant spreading due to groundwater flow), dispersion (contaminant spreading due to the tortuous flow of groundwater in porous or fractured

media), sorption (contaminant sorption from groundwater onto soil particles), diffusion (contaminant spreading due to chemical concentration gradients, including diffusion from groundwater into rock or clay matrix), dilution (mixing with uncontaminated groundwater), and volatilization (contaminant volatilization to the soil gas and/or atmosphere).

The use of natural attenuation is not a recent remedial technology development. In the Superfund program, the selection of natural attenuation as an element of a site's groundwater remedy dates as far back as 1985. In recent years, the groundwater remediation scientific/engineering community has realized significant advancements in the understanding of, and ability to evaluate, the natural capacity of subsurface environments to reduce contaminant concentrations to acceptable levels. These advancements have resulted in increased interest in, and implementation of, natural attenuation as an effective means of achieving soil and groundwater cleanup objectives.

A preliminary evaluation of existing data and conditions at the Site was conducted to identify evidence supporting the implementation of a monitored natural attenuation remedy. Indicators that a monitored natural attenuation remedy would be appropriate for the Site include:

- a) with the former operations at the Site occurring between 1974 and 1978, the introduction of contaminants to the subsurface occurred greater than 20 years ago. Over this substantial time frame, there has been significant opportunity for the occurrence of off-Site migration of contaminated groundwater.

Groundwater quality data were collected in 1984 and 1986 as part of the RI conducted at the Site (CH₂M Hill, 1988¹). These data demonstrated that Site-related contaminants had migrated only a short distance (100 to 150 feet) downgradient from the Site in the WTU, and at low concentrations. The lack of significant downgradient contaminant migration detected at the time of the RI demonstrates that naturally occurring processes serve to inhibit contaminant movement at the Site.

Groundwater quality data were collected in 1991 as part of the Pre-Design Activities (CRA, 1992²). Comparison of the RI and 1991 Pre-Design Activities groundwater quality data indicates stable to receding plume conditions in groundwater. Contaminant levels detected in 1991 were similar to those

¹ CH₂M Hill, 1988, Final Remedial Investigation Report, Summit National Site, Deerfield, Ohio, EPA WA57-5L04, February 10.

² CRA, 1992, Technical Memoranda, Pre-Design Activities, Summit National Superfund Site, Deerfield Township of Portage County, Ohio, April.

detected during the RI, and no further downgradient contaminant movement was observed in either the WTU, UIU, or LIU. Some decreases in specific Site-related contaminants also were observed in 1991 compared to levels detected during the RI. The lack of downgradient contaminant migration and contaminant reductions in the 5-year time period that elapsed between the 1986 RI sampling and 1991 Pre-Design Activity sampling further demonstrate that steady-state to decreasing plume conditions existed prior to the implementation of the GWES. Steady-state to decreasing plume conditions provides evidence of natural attenuation processes occurring at the Site;

- b) at the time the RI sampling was conducted in 1984 and 1986, significant levels of trichloroethene (TCE) and 1,1,1-trichloroethane (1,1,1-TCA) were detected in groundwater at the Site, particularly in monitoring wells installed in close proximity to the former concrete pad located in the central portion of the Site (i.e., the abandoned monitoring wells 2BB5, 2BB6, and MW9). Solvents applied in manufacturing operations in the mid to late 1970s (the time when solvent recycling operations were conducted at the Site) typically were TCE or 1,1,1-TCA based, although the exact composition of the solvents handled at the Site is unknown. The VOCs 1,1-dichloroethane (1,1-DCA) and 1,2-dichloroethene (total) [1,2-DCE (total)], comprised of cis-1,2-dichloroethene (c-1,2-DCE) and trans-1,2-dichloroethene (t-1,2-DCE), presently are prominent in groundwater at the Site and are included in the Site-Specific Indicator Parameter List (SSIPL). The anaerobic biodegradation of 1,1,1-TCA leads to the formation of 1,1-DCA (Vogel et al., 1987³). The prominent detection of 1,1-DCA may support the occurrence of anaerobic 1,1,1-TCA biodegradation in groundwater. The anaerobic biodegradation of TCE predominantly leads to the formation of c-1,2-DCE (Bouwer, 1984⁴). The detection of 1,2-DCE (total) does not directly demonstrate the occurrence of anaerobic TCE biodegradation, however, the significant presence of 1,2-DCE (total) is consistent with the occurrence of anaerobic TCE degradation in groundwater at the Site;
- c) significant levels of benzene, toluene, ethylbenzene, and xylene (BTEX) compounds and acetone have been detected in groundwater at the Site which is favorable for the biodegradation of organic compounds to occur. BTEX compounds provide a carbon source utilized by anaerobic bacteria as a primary

³ Vogel, T.M., C.S. Criddle, and P.L. McCarty, 1987, Transformations of Halogenated Aliphatic Compounds, *Environmental Science and Technology*, Vol. 21, No. 8, pp. 722-736.

⁴ Bouwer, E.J., 1994, Bioremediation of Chlorinated Solvents using Alternative Electron Acceptors, In: *Handbook of Bioremediation*: (Norris, R.D., Hinchee, R.E., Brown, R., McCarty, P.L., Semprini, L., Wilson, J.T., Kampbell, D.H., Reinhard, M., Bouwer, E.J., Borden, R.C., Vogel, T.M., Thomas, J.M., and Ward, C.H., Eds.), Lewis Publishers, Boca Raton, FL, p. 149-175.

growth substrate (Weidemeier et al., 1995⁵). The microbial degradation of this carbon source can drive the anaerobic biodegradation (via reductive dechlorination) of the chlorinated VOCs detected at the Site (Weidemeier et al., 1996⁶). Acetone also may represent a source of primary growth substrate necessary to sustain bacterial activity under anaerobic conditions (Major et al., 1995⁷);

- d) the greater than 20-year time frame since the introduction of contamination to the subsurface at the Site has provided significant opportunity for the acclimation of indigenous subsurface bacteria creating favorable conditions for continued biodegradation of Site-related contamination;
- e) potential receptors of Site-impacted groundwater within the WTU do not exist downgradient from the Site. On-Site groundwater within the WTU flows toward the south into a landfill site;
- f) potential receptors of Site-impacted groundwater do not exist immediately downgradient from the Site in the UIU or LIU. The nearest residential wells are cross-gradient, east of the Site;
- g) during the RA conducted at the Site (CRA, 1995), source removal activities were conducted during which all known buried drums and underground storage tanks were excavated and removed from the Site. In addition, surficial soils in specified areas of the Site were excavated (to a depth of 2 feet) and treated using an on-Site incinerator. As a result, the potential for continued contaminant releases from these sources no longer exists;
- h) since startup of the GWES in September 1994, consistently low levels of Site-related contaminants have been detected in groundwater extracted from the Site. The low contaminant levels in the extracted groundwater suggest that natural processes may have substantially decreased the WTU contamination, or may be preventing significant contaminant migration;

⁵ Wiedemeier, T. H., J. T. Wilson, D. H. Kampbell, R. N. Miller, and J. E. Hansen, 1995, Technical Protocol for Implementing Intrinsic Remediation with Long-Term Monitoring for Natural Attenuation of Fuel Contamination Dissolved in Groundwater, Revision 0, Air Force Center for Environmental Excellence, Technology Transfer Division, Brooks Air Force Base, San Antonio, Texas, November.

⁶ Wiedemeier, T. H., M. A. Swanson, D. E. Moutoux, E. K. Gordon, J. T. Wilson, B. H. Wilson, D. H. Kampbell, J. E. Hansen, P. Haas, F. H. Chapelle, 1996, Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater, Draft - Revision 1, November, Air Force Center for Environmental Excellence, Technology Transfer Division, Brooks Air Force Base, San Antonio, Texas, November.

⁷ Major, D., E. Cox, E. Edwards, and P. Hare, 1995, Intrinsic Dechlorination of Trichloroethene to Ethene in a Bedrock Aquifer, In: Hinchee, R.E., J.T. Wilson, and D.C. Downey, eds., Proceedings of the Third International In Situ and On-Site Bioreclamation Symposium, San Diego, California, Battelle Press

- i) the existing monitoring well network can be utilized to implement a long-term monitoring program to ensure the continued protectiveness of a natural attenuation remedy; and
- j) a contingency measure is a necessary component of a monitored natural attenuation remedy to address potential off-Site contaminant migration, should this be identified through long-term monitoring. The existing hydraulic containment and GWTS would satisfy this contingency measure requirement of a natural attenuation remedy.

Therefore, CRA recommends that SNFT petition USEPA and OEPA to pursue a monitored natural attenuation remedy for the Site.

4.0 RECOMMENDED ALTERNATE REMEDIAL ACTION

As described in Section 3.7, substantial evidence exists demonstrating the occurrence of natural attenuation processes at the Site. Comparison of the 1984 and 1986 RI groundwater quality data to the groundwater quality data collected during the 1991 Pre-Design Activities demonstrates that steady-state to declining plume conditions existed in groundwater prior to implementation of the GWES. The source removal activities conducted during the RA serve to enhance the steady-state to declining plume conditions. There is no demand on groundwater as a potable source in the immediate vicinity and hydraulically downgradient from the Site. In addition, the existing GWES and GWTS can be maintained as a contingency measure in the event that monitoring identifies that natural attenuation processes are not preventing significant contaminant movement from the Site.

4.1 USEPA PERSPECTIVE ON MONITORED NATURAL ATTENUATION

Natural attenuation is defined in the NCP to be naturally occurring processes that effectively reduce contaminant concentrations to levels which are protective of human health and the environment (Federal Register, 1990⁸). In the NCP, USEPA recognizes, and acknowledges, that natural attenuation *"will effectively reduce contaminants in the groundwater to concentrations protective of human health in a timeframe comparable to that which could be achieved through active restoration"* (Federal Register, 1990).

The USEPA currently places considerable focus on the evaluation and utilization of natural attenuation processes as an effective remedial alternative for contaminated sites. The inability of active remediation technologies (e.g., pump-and-treat) to achieve health-based cleanup objectives for soil and groundwater has become more widely recognized in recent years. With this recognition, the importance of utilizing naturally occurring processes that serve to reduce contaminant mass and concentrations in soil and groundwater as a component of remediation programs has become more apparent.

USEPA's Office of Solid Waste and Emergency Response (OSWER) recently issued the directive entitled, "Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites" (OSWER Directive) (USEPA,

⁸ Federal Register, 1990, Volume 55, No. 46, March 8, 40 CFR Part 300, National Oil and Hazardous Substances Pollution Contingency Plan; Final Rule.

1997⁹). The OSWER Directive provides guidance on the proposal, evaluation, and implementation of MNA at contaminated sites. In the OSWER Directive, the terminology MNA refers to the reliance on natural attenuation processes to achieve site-specific remedial objectives within a time frame that is reasonable compared to that offered by other more active remedial alternatives. No written quantification of what constitutes a reasonably comparable timeframe has been made available by USEPA. However, at a recent USEPA training seminar on MNA (USEPA, 1998a¹⁰), the USEPA lecturer speaking on the Framework for Use of MNA (Fran Kramer, who is also listed as a USEPA MNA contact in the OSWER Directive) indicated that a remediation timeframe for a MNA remedy should be considered reasonable if it is within two to three times greater than the timeframe for an active groundwater remedy. The USEPA does not consider a MNA remedy to be a "no action", or a "walk away" scenario. Rather, the USEPA considers MNA as a proactive approach that focuses on the confirmation and monitoring of contaminant reduction by natural attenuation processes, as opposed to solely relying on active technologies (USEPA, 1996¹¹).

The OSWER Directive forms USEPA's policy regarding the implementation of a MNA remedy at a site. The publication of the OSWER Directive affirms USEPA's recognition of natural attenuation as a viable remedial alternative under the Superfund, Resource Conservation and Recovery Act (RCRA) Corrective Action, and Underground Storage Tank (UST) remediation programs. Within the Superfund program, MNA had been selected as one of the cleanup methods at 73 groundwater contaminated sites by 1996 (USEPA, 1996). MNA is being incorporated into many more site remedies, including sites with existing RODs.

Subsequent to the release of the OSWER Directive, USEPA most recently issued the document entitled, "Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater" (MNA Technical Protocol) (USEPA, 1998b¹²). The MNA Technical Protocol provides technical guidelines for the collection and analysis of data to evaluate the suitability of MNA for sites where groundwater has been impacted by chlorinated compounds. The issuance of the MNA Technical Protocol further affirms USEPA's commitment to give consideration and approval to the implementation of MNA as a viable remedial alternative.

⁹ Federal Register, 1990, Volume 55, No. 46, March 8, 40 CFR Part 300, National Oil and Hazardous Substances Pollution Contingency Plan; Final Rule.

¹⁰ USEPA, 1998a, Seminars: Monitored Natural Attenuation for Groundwater, EPA/625/K-98/001.

¹¹ USEPA, 1996, A Citizen's Guide to Natural Attenuation, EPA/542/F-96/015, Office of Solid Waste and Emergency Response, Washington, DC, October.

¹² USEPA, 1998b, Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater, EPA/600/R-98/128, Office of Solid Waste and Emergency Response, Washington, DC, September.

4.2 SITE CONDITIONS FAVORABLE TO MONITORED NATURAL ATTENUATION

USEPA's acceptance of MNA as a site remedy is contingent on the evaluation of observed site data to demonstrate that natural attenuation processes are capable of effectively reducing contaminant levels and preventing contaminant migration to potential receptors to an extent that is protective of human health and the environment. The OSWER Directive promotes the use of a "weight-of-evidence" approach where multiple lines of evidence converge to scientifically document the occurrence of natural attenuation processes at a site. The OSWER Directive identifies the following three lines of evidence that can be used to evaluate the occurrence of natural attenuation processes at a site:

- a) historical groundwater and/or soil chemistry data that demonstrate a clear and meaningful trend of decreasing contaminant mass and/or concentration over time at appropriate monitoring or sampling points;
- b) hydrogeologic and geochemical data that can be used to demonstrate indirectly the type(s) of natural attenuation processes active at the site and the rate at which such processes will reduce contaminant concentrations to required levels. For example, characterization data may be used to quantify the rates of contaminant sorption, dilution, or volatilization, or to demonstrate and quantify the rates of biological degradation processes occurring at the site; and
- c) data from field or microcosm studies (conducted in or with actual contaminated site media) which directly demonstrate the occurrence of a particular natural attenuation process at the site and its ability to degrade the contaminants of concern (typically used to demonstrate biological degradation processes only).

In providing guidance on the interpretation of the above types of evidence, USEPA indicates that historical data of sufficient quality and duration that demonstrate a declining trend in groundwater contamination that is not solely due to plume migration [i.e., item a) above] is adequate to support a decision to implement MNA. In the OSWER Directive, USEPA indicates that if available data to support item a) are of insufficient quality or duration, then data characterizing the type of the natural attenuation processes [i.e., item b) above] occurring at a site should be provided. Where data for items a) and b) are inadequate or inconclusive, data from field or microcosm studies [i.e., item c) above] may be necessary.

In general, historical monitoring data are the most reliable basis for determining whether monitored natural attenuation is an appropriate remedy at a site (USEPA, 1997). If monitoring data are not conclusive, modeling may assist in the evaluation, however, modeling results are inherently less reliable than historical monitoring data. Modeling may be required if the selected remedy includes actions which may affect natural attenuation processes (e.g., source removal or landfill capping). Field or microcosm studies of microbiological conditions are usually only considered if monitoring data and model results do not lead to a conclusive evaluation.

In general, a MNA remedy is considered feasible for sites where the following conditions are satisfied:

- a) the exposure to contaminants at potential receptors is mitigated;
- b) the potential migration of contaminants into uncontaminated media is limited;
- c) the plume of contaminated groundwater is relatively dilute; and
- d) the source of contamination has been removed, depleted, or controlled.

The site considerations provided by USEPA in the OSWER Directive for assessing the appropriateness of MNA are presented below, followed by statements indicating how they are satisfied at the Site based on the evidence presented above:

- a) **whether the contaminants present in soil or groundwater can be effectively remediated by natural attenuation processes:**

The VOCs detected in groundwater at the Site are readily biodegraded under anaerobic conditions. Based on the abundant presence of daughter product VOCs detected at the Site, significant evidence exists supporting the occurrence of anaerobic biodegradation at the Site;

- b) **whether the resulting transformation products present a greater risk than do the parent contaminants:**

The lack of downgradient movement of transformation products, as well as parent VOCs, between the 1986 RI and the 1991 Pre-Design Activities sampling demonstrate that the transformation products are readily attenuated and do not pose a greater risk than the parent VOCs;

- c) **the nature and distribution of sources of contamination and whether these sources have been or can be adequately controlled:**

As described above, all known buried drums and underground storage tanks were excavated and removed during the RA conducted at the Site. In addition,

surficial soils in specified areas of the Site were excavated (to a depth of 2 feet) and treated using an on-Site incinerator. As a result of these activities, substantial sources of groundwater contamination have been removed reducing the potential for further contaminant releases to groundwater;

- d) **whether the plume is relatively stable or is still migrating, and the potential for environmental conditions to change over time:**

The similar to lower VOC levels detected in the 1991 Pre-Design Activities groundwater samples in comparison to the 1984 and 1986 RI groundwater quality data demonstrate that stable to decreasing plume conditions existed prior to the installation of the GWES.

Presently, no on-Site WTU monitoring wells are located within, or immediately downgradient from, the area where the greatest contaminant levels were identified during the RI (i.e., the former source area at the former concrete pad in the central portion of the Site). Additional on-Site WTU monitoring wells would be required to adequately monitor the current nature of the former source area within the WTU previously identified during the RI;

- e) **the impact of existing and proposed active remediation measures upon the monitored natural attenuation component of the remedy:**

Source removal activities conducted during the RA have substantially reduced the potential for further contaminant releases to groundwater. Site grading (including removal of the two on-Site ponds) and capping activities conducted during the RA have reduced precipitation infiltration and, hence, have reduced a hydraulic driving force for groundwater flow and contaminant movement. All of these activities serve to enhance the steady-state to declining plume conditions that existed at the Site prior to implementing the GWES, as demonstrated by the 1991 Pre-Design Activities groundwater quality data;

- f) **whether drinking water supplies, other groundwaters, surface waters, ecosystems, sediments, air, or other environmental resources could be adversely impacted as a consequence of selecting monitored natural attenuation as the remediation option:**

Groundwater within the WTU in the Site vicinity is not suitable for, and is not used as, a potable water source. The background WTU groundwater conditions are generally of poor quality due to the extensive strip mining operations conducted in the area. The strip mining has resulted in high levels of metals, such as sulfate, iron, and manganese, in groundwater which renders the groundwater unsuitable as a potable water source. As a result, the implementation of a MNA remedy will not result in a potential adverse impact to drinking water supplies in the WTU.

Downward vertical hydraulic gradients from the WTU to the UIU/LIU were identified during the RI throughout the Site. The operation of the GWES has lowered groundwater levels within the WTU sufficiently to create upward vertical hydraulic gradients from the UIU/LIU to the WTU at the southern boundary of the Site. The downward vertical hydraulic gradients may recur in the event that pumping from the GWES is discontinued. In this instance, the potential for downward migration of WTU contamination to the UIU/LIU may exist. Ongoing monitoring as part of the MNA remedy will be required to monitor this potential downward contaminant migration into the UIU.

The potential exists for an ecological impact from the discharge of Site groundwater to the ditch along the southern Site boundary. Groundwater elevations measured during the RI along the southern Site boundary were higher than the present invert elevation of the ditch. Although the groundwater levels would be expected to recover some following the shut-down of the GWES, the groundwater levels would not be expected to recover to levels measured during the RI due to the grading and capping activities conducted at the Site which serve to reduce precipitation infiltration at the Site. In the event that a significant increase in the groundwater level occurs, groundwater management alternatives, such as phytoremediation that act to reduce groundwater levels, may be implemented to reduce groundwater discharge to the ditch. The GWES and the GWTS also will be maintained as contingency measures in the event that they are required to lower groundwater levels and prevent groundwater discharge to the ditch. Therefore, it is not expected that the implementation of a MNA remedy will result in an adverse ecological impact;

- g) **whether the estimated time frame of remediation is reasonable compared to time frames required for other more active methods (including the anticipated effectiveness of various remedial approaches on different portions of the contaminated soil and/or groundwater):**

Significant data are available documenting the inability of groundwater extraction systems, such as the GWES currently in operation at the Site, to achieve cleanup objectives within a measurable time frame. Considering the relatively low permeability and heterogeneous nature of the WTU till material, the potential that cleanup objectives can be achieved within the foreseeable future is unlikely. As a result, the implementation of a MNA remedy will not result in significant increases in the remediation time frame;

- h) **current and projected demand for the affected aquifer over the time period that the remedy will remain in effect (including the availability of other water supplies and the loss of availability of other groundwater resources due to contamination from other sources):**

As described above, groundwater within the WTU is not suitable for, and is not used as, a potable water supply; and

- i) **whether reliable site-specific vehicles for implementing institutional controls (i.e., zoning ordinances) are available, and if an institution responsible for their monitoring and enforcement can be identified:**

Since naturally occurring groundwater within the vicinity of the Site in the WTU is of such poor quality, there would be no future use of the WTU groundwater as a potable water source. Therefore, there is no need for additional institutional controls.

4.3 IMPLEMENTATION OF ALTERNATE REMEDIAL ACTION

Based on the discussions in the preceding subsections, MNA is recommended as an appropriate alternative remedial action for the Site.

The implementation of a MNA remedy would consist of the following activities:

- a) the cessation of pumping from the pipe and media drain, and of groundwater treatment, for an initial evaluation period (perhaps 5 years in duration);
- b) the installation of additional monitoring wells, if required, to monitor the effect of the natural attenuation occurring at the Site;
- c) the ongoing monitoring of groundwater quality throughout the Site; and
- d) the preservation of the pipe and media drain, and of the GWTS, as a contingency measure.

5.0 PROPOSED SCOPE OF WORK FOR THE ALTERNATE REMEDIAL ACTION

A scope of work was developed in consideration of USEPA's OSWER Directive and Technical Protocol, which provide guidance on the necessary elements for the evaluation and data required to support a MNA remedy, and in consideration of CRA's experience with the implementation of MNA remedies at other sites.

The scope of work is divided into an evaluation phase and a trial implementation phase. The evaluation component pertains to the work necessary to demonstrate the occurrence of natural attenuation processes at the Site to the extent that they are protective of human health and the environment. The trial implementation phase pertains to the work associated with a trial implementation of the MNA remedy for an initial 5-year assessment period, and the necessary monitoring program associated with this trial implementation, and includes the preparation of a MNA remedy support document for submission to USEPA and OEPA.

5.1 EVALUATION PHASE

The scope of work necessary to demonstrate the occurrence of natural attenuation processes at the Site to the extent that they are protective of human health and the environment is divided into the following tasks:

- i) installation of four new WTU monitoring wells in the vicinity of the former source area (i.e., the location of the former concrete pad in the central portion of the Site), as presented on Figure 1. These four WTU monitoring wells would serve to identify the contaminant levels remaining within, and any contaminant movement downgradient from, the former source area;
- ii) conduct a natural attenuation indicator parameter sampling event using low-flow purging (LFP) techniques to provide data relevant to oxidation-reduction (redox) reaction conditions, geochemical conditions, and the presence of biodegradation end products. A protocol for the natural attenuation indicator parameter sampling using LFP techniques is presented in Appendix A. The data will be evaluated to identify evidence supporting the occurrence of, and conditions favorable to, biodegradation of Site-related contaminants. The collection of groundwater samples for the analyses of natural attenuation indicator parameters would be required from 12 existing WTU monitoring wells, and the four new WTU monitoring wells. The collection of groundwater samples for the analysis of natural attenuation indicator parameters also would

be required from three UIU monitoring wells (MW-201, MW-207, and MW-223), and three LIU monitoring wells (MW-301, MW-307, and MW-321). Site-related VOCs were detected above background levels at the UIU monitoring wells MW-207 and MW-223, and at the LIU monitoring wells MW-307 and MW-321, during the groundwater quality monitoring conducted at the Site by CRA from 1995 to 1998. The UIU monitoring well MW-201 and the LIU monitoring well MW-301 are included to provide background redox and geochemical conditions in the UIU and LIU. The natural attenuation indicator parameter sampling network is presented on Figure 1;

- iii) evaluate the complete groundwater quality data set that exists for the Site for evidence supporting the occurrence of natural attenuation processes;
- iv) conduct an evaluation of the natural attenuation indicator parameter data for evidence supporting the occurrence of degradation processes;
- v) review of the adequacy of the existing long-term groundwater monitoring network to ensure the continued protectiveness of natural attenuation processes occurring at the Site, and to identify the occurrence of any future significant contaminant migration off Site;
- vi) prepare a detailed support document to clearly identify evidence demonstrating that naturally occurring processes are effectively reducing contaminant levels and preventing contaminant migration off Site to an extent that is protective of human health and the environment; and
- vii) establish additional support measures (i.e., phytoremediation augmentation) and contingency plans (i.e., maintenance of the GWES and GWTS for restart if necessary).

5.2 TRIAL IMPLEMENTATION PHASE

A trial implementation phase is proposed for the recommended alternate MNA remedy, and consists of an initial 5-year assessment period, followed by an evaluation of the effectiveness of the MNA remedy.

The trial implementation phase of the MNA remedy requires a monitoring program that will ensure the protectiveness of the remedy. The scope of work for the monitoring program to accompany the trial implementation phase of the MNA remedy for the initial 5-year evaluation period is divided into the following tasks:

- i) conduct an initial full TCL/TAL groundwater quality sampling and hydraulic monitoring round for all wells at the time the MNA remedy is implemented, and report the results to USEPA and OEPA;
- ii) shut down the GWES and GWTS, prepare the GWES and GWTS for idle storage, and maintain as such for the 5-year evaluation period of the MNA remedy;
- iii) conduct a SSIPL groundwater quality sampling and hydraulic monitoring round on a semi-annual basis for the first two years after implementing the MNA remedy, and report the results to USEPA and OEPA;
- iv) conduct a SSIPL groundwater quality sampling and hydraulic monitoring round on an annual basis for the third and fourth years after implementing the MNA remedy, and report the results to USEPA and OEPA;
- v) conduct a full TCL/TAL groundwater quality sampling and hydraulic monitoring round for all wells in the fifth year after implementing MNA remedy, and report the results to USEPA and OEPA. A second natural attenuation indicator parameter sampling round would be conducted at this time, and the data collected would be evaluated to ensure the continued occurrence of natural attenuation processes at the Site; and
- vi) conduct an annual review of the monitoring data to ensure that the MNA remedy remains protective of human health and the environment during the initial trial evaluation period and beyond, and report the results of the reviews to USEPA and OEPA.

At the end of the initial 5-year trial evaluation period, a recommendation for continued Site remediation will be prepared and submitted to USEPA and OEPA.

**6.0 PROPOSED IMPLEMENTATION SCHEDULE
FOR THE ALTERNATE REMEDIAL ACTION**

The following initial 5-year schedule is proposed to evaluate and implement a MNA remedy at the Site:

<i>Activity</i>	<i>Proposed Schedule</i>
a) Present and discuss with USEPA and OEPA at the Site the recommended MNA alternate remedy	March 1999
b) Prepare and submit a MNA Work Plan to USEPA and OEPA for approval, including community relations meetings to keep the local residents informed of the progress of the proposed RA enhancements	March to April 1999
c) Implement the MNA Work Plan, including installation of additional monitoring wells, LFP sampling and analyses, evaluation of natural attenuation mechanisms at the Site, and preparing and submitting a MNA evaluation report to USEPA and OEPA	May to July 1999
d) Shutdown the GWES and GWTS on approval from USEPA and OEPA, and commence operation, maintenance, and monitoring of the MNA alternate remedy	August 1999
e) Continue groundwater hydraulic monitoring coincident with each groundwater quality monitoring event	1999 to 2004
f) Biannual SSIPL groundwater quality monitoring	1999 to 2001
g) Annual SSIPL groundwater quality monitoring	2002 to 2003
h) TCL/TAL groundwater quality monitoring	1999, 2004
i) Annual MNA Report	2000, 2001, 2002, 2003, 2004
j) 5-Year Review of MNA Remedy	2004

FIGURES

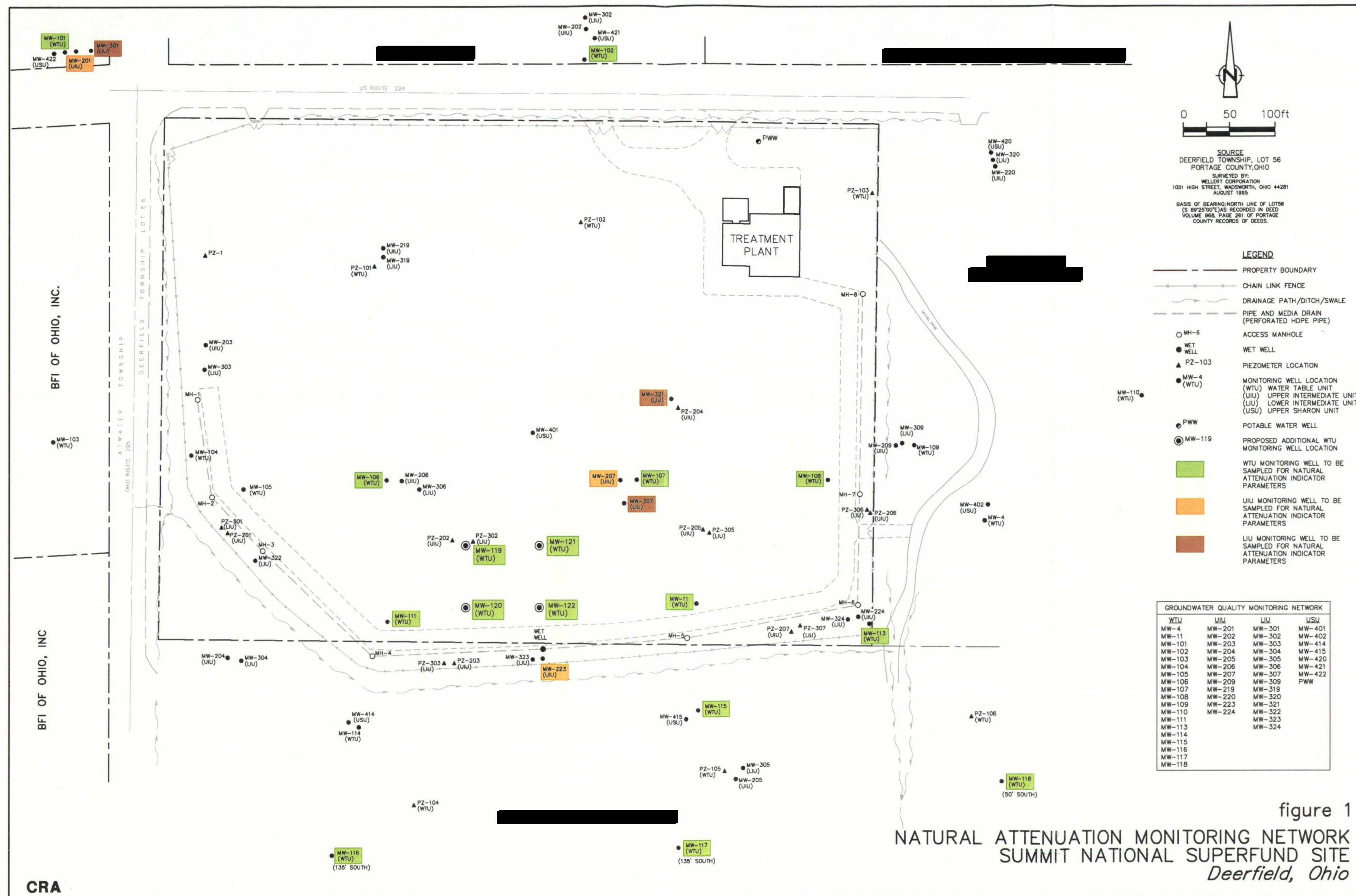


figure 1
NATURAL ATTENUATION MONITORING NETWORK
SUMMIT NATIONAL SUPERFUND SITE
Deerfield, Ohio

TABLES

TABLE 1
SUMMARY - INFLUENT MONITORING
GROUNDWATER TREATMENT SYSTEM
SUMMIT NATIONAL SUPERFUND SITE
DEERFIELD, OHIO

Chemical	Final Design Report					Calculated Effluent	Actual Treatment Plant Influent Concentrations						OEPA Discharge Limits Nov. 22, 1994	APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (From Table 6.2 of Final Design Report)								
	Estimated Influent Concentrations				Maximum Estimated Influent		1994 - 1998			1998				of Aquatic Life				Target Level				
	Time From Startup			Minimum			Maximum	Average	Minimum	Maximum	Average	Maximum Contaminant Level MCL		Proposed Maximum Contaminant Level pMCL	Freshwater Protection Acute/Chronic	AWQC Water and Fish Ingestion	AWQC Fish Only Ingestion	HI of 1 Based on Individual Compounds	Public Water Supply	30-Day Average	Human Health 30-Day Average	
	90 days	2.6 Years	5.2 Years																			
Organic Compounds (µg/L)																						
Acetone	12	46,347	4,756	46,347	927	ND(0.92)	ND(50)	ND	ND(0.92)	ND(0.92)	ND	927	3,50078,000									
Benzene	7.1	5.1	5.1	7		ND(0.4)	ND(5)	ND	ND(0.4)	ND(0.4)	ND	7	5									
1,1-Dichloroethane	57	295	359	359	7	3.7	24	7.9	4	13.5	7.8	7	3,500									
1,2-Dichloroethane	181	1,049	717	1,049	21	5	67	16.2	6.7	29.8	13.3	21	5	118,000/20,000	0.94/0.38	243/98.6	3.8	3,500	990			
1,1-Dichloroethylene	2.5	1.8	1.8	2	<1	ND(0.97)	ND(0.97)	ND	ND(0.97)	ND(0.97)	ND	5	7	11,600	0.033/0.057	1.85/3.2	315	0.57	78	32		
1,2-Dichloroethylene	26	663	1,201	1,223	24	5.7	44.8	26.1	9.9	44.3	29.4	26	70	310								
Ethylbenzene	1.7	4.9	11	26	1	ND(0.76)	ND(5)	ND	ND(0.76)	ND(0.76)	ND	5	700	32,000	1,400/3,120	3,280/28,720	3,500	3,100	62	29,000		
Methylene Chloride	0.0	132	145	145	3	ND(0.64)	2.6	2.6	ND(0.64)	ND(0.64)	ND	5	5	11,000	0.19/4.7	15.7/1,578	2,100		430			
Methyl Ethyl Ketone	0.1	22,103	6,514	22,103	442	ND(0.62)	10	10	ND(0.62)	ND(0.62)	ND	442		1,7507,100								
Methyl Isobutyl Ketone	0.4	754	686	756	15	ND(1.3)	ND(50)	ND	ND(1.3)	ND(1.3)	ND	15	1,750									
Toluene	2.8	47	121	260	5	ND(0.38)	ND(5)	ND	ND(0.38)	ND(0.38)	ND	5	1000	17,500	14,300/6,765	424,000/201,300	7,000	10,000	1,700	300,000		
1,1,1-Trichloroethane	99	206	399	602	12	2	12	3.9	2	7.4	3.9	12	200		18,400	1,030,000	70,000	200	88	1,030,000		
Trichloroethylene	1.5	1.4	1.4	1.5		1.4	12	5.4	2.4	11	6.7	5	5									
Xylene (Total)	9.3	62	147	289	6	ND(1)	ND(5)	ND	ND(1)	ND(1)	ND	6	10,000									
Base/Neutral Compounds (µg/L)																						
Bis(2-Ethylhexyl)Phthalate	--	0.7	0.7	1	<1	ND(2.1)	ND(10)	ND	ND(2.1)	ND(2.1)	ND	10	6	400/360	1.76	5.9	700	18	8.4	59		
Isophorone	--	35	38	38	1	ND(1.4)	ND(10)	ND	ND(1.4)	ND(1.4)	ND	10		117,000	5,200/8.4	520,000/598	7,000					
2-Methyl Naphthalene	--	0.7	0.7	1	<1	ND(2.0)	ND(10)	ND	ND(2.0)	ND(2.0)	ND	10										
Naphthalene	--	0.5	0.7	1	<1	ND(1.6)	ND(10)	ND	ND(1.6)	ND(1.6)	ND	10		2,300/620	14044							
Acid Compounds (µg/L)																						
4 Chloro 3 Methyl Phenol	--	1.9	0.1	2	<1	ND(1.2)	ND(10)	ND	ND(1.2)	ND(1.2)	ND	10										
2,4-Dimethyl Phenol	--	1.0	0.9	1	<1	ND(2.8)	ND(10)	ND	ND(2.8)	ND(2.8)	ND	10		2,120	400	700						
2-(O-Cresol) Methyl Phenol	--	2.6	1.9	3	<1	ND(1.7)	ND(10)	ND	ND(1.7)	ND(1.7)	ND	10	1,75022									
4-(P-Cresol) Methyl Phenol	--	20	17	20	<1	ND(2.4)	ND(10)	ND	ND(2.4)	ND(2.4)	ND	10	1,7506.2									
Phenol	--	159	106	158	3	ND(0.67)	ND(10)	ND	ND(0.67)	ND(0.67)	ND	10		10,200/2,560	300	46,163 ppm	21,000	1	200			
Inorganic Compounds (µg/L)																						
Antimony	--	--	--	5	5	ND(5)	ND(7)	ND	ND(5)	ND(5)	ND	30	6	9,000/1,600	14	4,400	14	14	190	4,300		
Arsenic	--	--	--	7	7	ND(3)	8.3	8.3	ND(5)	ND(5)	ND	190	50	50	360/190	0.0022/0.018	0.018/0.14	35	50	190		
Iron	--	--	--	149,690	300	180	95,400	40679	13,800	69,000	39209	1,000	300	11,000	300			300	1,000			
Aluminum	--	--	--	536	536	70	452	189.3	ND(200)	276	276.0	*		750/87								
Barium	--	--	--	219	219	11	21	16.1	ND(200)	ND(200)	ND	500	2,000	1,000				2,450	1,000			
Calcium	--	--	--	403,571	201,785	154,000	350,000	293429	250,000	330,000	289273	*										
Chromium	--	--	--			ND(5)	9	8.8	ND(10)	ND(10)	ND	20										
Cobalt	--	--	--	14	14	10	17	14.8	10	17	15.6	*										
Copper	--	--	--	2	2	1.3	7	3.1	2	7	3.5	90	1,300	9/6.5	1,000	1,295				1,000	12	52
Lead	--	--	--	1	1	ND(1)	ND(10)	ND	ND(1)	ND(1)	ND	50	50	82/3.2	50	49				50	6.9	54
Magnesium	--	--	--	144,301	72,151	63,000	159,000	96774	63,000	128,000	88418	*										
Manganese	--	--	--	6,818	6,818	1,900	4,880	3759	2,150	4,880	3605	*										
Nickel	--	--	--	14	14	2	47	17.9	2	16	10.5	200	100	789/87.7	610	4,600	700	610	170	700		
Potassium	--	--	--	12,829	6,415	5,100	10,400	6539.1	5,130	7,120	6213	*										
Zinc	--	--	--	188	188	20	57	76.7	22.7	57	49.2	200	5,000	65/58.9	5,000	5,000				110	410	

Note: ARAR Exceedance

TABLE 1
SUMMARY - INFLUENT MONITORING

APPENDIX A

LOW-FLOW PURGING AND NATURAL ATTENUATION INDICATOR PARAMETER SAMPLING PROTOCOL

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A.1.0 INTRODUCTION

This appendix summarizes the low-flow purging (LFP) and groundwater sampling protocol recommended to obtain analytical data necessary to conduct a natural attenuation evaluation at the Summit National Superfund Site (Site) in Deerfield, Ohio. The groundwater samples are to be analyzed for natural attenuation indicator parameters, which include oxidation-reduction (redox) reaction indicator parameters, geochemical indicator parameters, and degradation products. The protocol described herein applies LFP techniques to obtain samples that are representative of groundwater moving through the subsurface under natural conditions. The analytical data provided by these samples will facilitate an evaluation of the natural attenuation processes occurring at the Site. The LFP techniques described herein also are to be applied to collect groundwater samples for analyses of the full Target Compound List/Target Analyte List (TCL/TAL) and Site-Specific Indicator Parameter List (SSIPL) that are required during specific sampling events in accordance with the monitoring program.

Section A.2 presents the protocol to collect groundwater samples for the analysis of the natural attenuation indicator parameters using LFP techniques. The LFP techniques also are to be applied to collect groundwater samples for the analysis of the TCL/TAL and the SSPL. Section A.3 presents a list of references cited in this appendix.

A.2.0 LFP AND NATURAL ATTENUATION

INDICATOR PARAMETER SAMPLING PROTOCOL

The LFP techniques described herein are in accordance with United States Environmental Protection Agency (USEPA) low-flow procedures (Puls and Barcelona, 1996), the USEPA Region I low-flow standard operating procedure (SOP) (USEPA, 1996), and the USEPA Region II low-flow purging and sampling procedures (USEPA, 1998). The groundwater samples are to be analyzed for the natural attenuation indicator parameters listed in the attached Table A.1. Table A.1 indicates the recommended laboratory analysis method for each parameter, and describes the use of each parameter, for a natural attenuation evaluation.

Each monitoring well will be sampled using the following LFP protocol.

1. The groundwater level in the monitoring well will be measured to the nearest 0.01 foot using a pre-cleaned electric water level tape.
2. Purging will be conducted using a pre-cleaned stainless-steel bladder pump with a teflon bladder. The pump discharge line may be polyethylene tubing (if tubing is to be discarded between wells or dedicated to wells, otherwise teflon or teflon-lined tubing is required) with an inside diameter of 1/4 or 3/8 inch (a smaller diameter tubing ensures the discharge line remains water filled with no air bubbles at low flow purging rates). The air supply line for the bladder pump operation may be polyethylene. The bladder pump will be secured in the monitoring well with nylon rope and positioned in the well in accordance with Item 3 below.
3. The total depth of the monitoring well from the top of casing (TOC) will be measured to the nearest 0.01 foot using a pre-cleaned measurement device, such as water level plover. The measured well depth will be compared to the constructed well depth to evaluate the presence of any sediment accumulated at the well bottom. The use of a wide-based measurement device, such as a water level plover, may minimize penetration of any sediment facilitating a reliable measurement. The measurement device will be lowered slowly to the well bottom to minimize mixing of the stagnant well casing water and to minimize agitating any solids into suspension. The depth of any well bottom sediment will be considered when positioning the pump intake to avoid mobilizing any sediment present at the well bottom while purging (which will increase the purging time). A minimum of 2 feet should be maintained between the pump

intake and the well bottom, or sediment level if present. The bladder pump will be positioned and secured such that the pump intake corresponds to the mid-point of the well screen, or a minimum of 2 feet above the well bottom or sediment level if present, whichever is more shallow. The appropriate depth to the pump intake from the TOC will be determined as described above before positioning the bladder pump. The required nylon rope length will be pre-measured before lowering the bladder pump into the monitoring well to ensure accurate positioning of the pump intake. The bladder pump will be lowered very slowly into position to minimize mixing of the stagnant well casing water and to minimize the agitation of any solids into suspension (which will increase purging time). If feasible, the bladder pump will be placed in the well a few hours prior to purging to allow any disturbed sediment to settle.

As described in Item 6 below, purging will be continued until stabilization of the purged groundwater is achieved, or until a maximum 20 monitoring well screen volumes of groundwater have been purged (unless stabilization is eminent after purging 20 screen volumes). Since LFP likely will not draw groundwater from a significant distance above or below the pump intake, the screen volume will be determined using a 5-foot screen length. This 5-foot screen length is based on 2.5 feet above and below the pump intake, provided the well screen extends over this distance. If a 2.5-foot length of well screen does not exist above and below the pump intake, the actual length of well screen above and below the pump intake will be used to determine the screen volume (i.e., the pump intake position in relation to the well bottom, or sediment level if present, and top of screen will be accounted for when determining the screen volume). The screen volume will be determined before purging begins.

4. Static groundwater level conditions in the monitoring well will be allowed to re-establish after lowering the bladder pump into position. The groundwater level in the monitoring well will be measured (to the nearest 0.01 foot) with the bladder pump in place prior to beginning purging.
5. Purging of the monitoring well will be conducted using a pumping rate between 100 to 500 milliliters per minute (mL/min). Initial purging will begin using a pumping rate within the lower end of this range. The groundwater level will be measured while purging to ensure that less than 0.3 feet of drawdown occurs. The pumping rate may be gradually increased depending upon the amount of drawdown and the behavior of the stabilization parameters (see Item 6 below). Pumping rate adjustments generally will be made within 15 minutes from the start of purging and then should remain constant for the duration of purging.

While purging, the pumping rate and groundwater level will be measured and recorded every 10 minutes (or as appropriate). If it appears that stabilization of the purged groundwater (see Item 6 below) will not be achieved rapidly, these measurements may be made at longer time intervals to allow field staff to perform other sampling activities.

6. Stabilization of the purged groundwater is necessary prior to sample collection to ensure that the sample is representative of groundwater in the subsurface only, and is not influenced by stagnant groundwater stored in the well casing. The field parameters listed in the attached Table A.2 [pH, temperature, conductivity, oxidation-reduction (redox) reaction potential (ORP), dissolved oxygen (DO), and turbidity] will be monitored while purging to evaluate the stabilization of the purged groundwater. As stabilization approaches, the field parameters will be measured and recorded every 5 minutes (or as appropriate). Stabilization will be considered to be achieved when three consecutive readings for each parameter, taken at 5-minute intervals, are within the following limits:

pH	±0.1 pH units of the average value of the three readings;
temperature	±3 percent of the average value of the three readings;
conductivity	±3 percent of the average value of the three readings;;
ORP	±10 millivolts (mV) of the average value of the three readings;
DO	±10 percent of the average value of the three readings; and
turbidity	±10 percent of the average value of the three readings, or a final value of less than 5 nephelometric turbidity units (NTU).

The field parameters will be measured using a flow-through-cell apparatus. At the start of purging, the purge water will be visually inspected for water clarity prior to connecting the flow-through-cell. If the purge water appears turbid, purging will be continued until the purge water becomes visually less turbid before connecting the flow-through-cell. The attached Table A.3 provides a chart to follow while recording the field parameters and other pertinent data. Measurement of the field parameters may be obtained using individual meters or a multiple meter unit. The meters will be calibrated prior to use each day in accordance with the meter manufacturer's instructions. While purging, the meter readings will be monitored for evidence of meter malfunction. The following are common indicators of meter malfunctions:

- DO above solubility [e.g., oxygen solubility is approximately 11 milligrams per liter (mg/L) at 10 degrees Celsius] may indicate a DO meter malfunction;

- negative ORP and DO greater than 1 to 2 mg/L may indicate either an ORP or a DO meter malfunction (i.e., should have positive ORP and DO greater than 1 to 2 mg/L under oxidizing conditions); and
- positive ORP and DO less than 1 mg/L may indicate either an ORP or a DO meter malfunction (i.e., should have negative ORP and DO less than 1 mg/L under reducing conditions).

Meter calibration fluids will be available for meter re-calibration in the field, if necessary. Spare meters will be available for meter replacement, if necessary.

In general, stabilization of the individual field parameters is considered to occur in the order listed above. Should stabilization not be achieved for all field parameters, purging will be continued until a maximum of 20 monitoring well screen volumes have been purged from the well. Since LFP likely will not draw groundwater from a significant distance above or below the pump intake, the screen volume will be based upon a 5-foot screen length, or based on the actual length of well screen above and below the pump intake as described in Item 3 above. After purging 20 well screen volumes, purging will be continued if the purge water remains visually turbid and appears to be clearing, or if stabilization parameters are varying slightly outside of the stabilization criteria listed above and appear to be approaching stabilization.

In the event that the groundwater recharge to the monitoring well is insufficient to conduct the LFP protocol, purging should be discontinued before the water level in the monitoring well drops below the top of the pump. Samples will be collected as soon as the volume of groundwater in the well has recovered sufficiently to allow sample collection. Wells in which recovery is insufficient to conduct the LFP protocol will not be subject to the above purging stabilization criteria.

7. After achieving stabilization, each sample to be analyzed for the natural attenuation parameters listed in Table A.1 (with the exception of the dissolved gasses methane, ethene, and ethane) will be field filtered using an in-line filter [0.45 micrometers (μm)]. Filtering is required for the natural attenuation parameters to enable a determination of truly dissolved phase concentrations of major ions and indicator metals (Puls and Barcelona, 1996) (for example, ferrous iron). The filtering of additional groundwater samples for the analyses of Site-related compounds of concern (COCs) (i.e., VOCs, SVOCs, or metals) is not recommended in conjunction with LFP, and will be based upon the quality assurance project plan (QAPP) established for the Site.

The attached Table A.4 presents a list of sample containers, preservation, shipping, and packaging requirements for the natural attenuation parameters listed in Table A.1. The flow-through-cell will be disconnected prior to sample collection to avoid impact to the sample that may result from contamination that may potentially accumulate within the flow-through-cell during purging. The sample bottle will be filled by allowing the discharge to gently flow down the side of the sample bottle and the sample bottle will be allowed to overflow slightly before sealing (overflow is not recommended if the sample bottles have been prepared with preservatives). Sample bottles will be sealed and prepared for delivery to the laboratory as described in Table A.4.

8. Duplicate samples will be collected at a frequency of 1 per 10 investigative samples, or in accordance with the QAPP established for the Site.
9. All purge water will be containerized and stored on Site pending disposal in accordance with established Site procedures. The nylon rope, discharge tubing, and air tubing will be replaced before sampling the next monitoring well. All used rope and tubing will be containerized and stored on Site pending disposal, or will be dedicated to the monitoring well for future sampling events (as appropriate). The bladder pump will be decontaminated following the procedures outlined in Item 10 below.
10. The daily and between well decontamination procedures described below will be implemented for the equipment associated with the LFP technique:

Daily Decontamination

- The bladder pump will be operated for a period of 5 minutes in a deep basin containing 8 to 10 gallons of potable water. All other equipment will be flushed with potable water for a period of 5 minutes.
- The bladder pump will be operated for a period of 5 minutes in a deep basin containing 8 to 10 gallons of a non-phosphate detergent solution, such as Alconox™. All other equipment will be flushed with fresh detergent solution for a period of 5 minutes.
- The bladder pump will be operated for a period of 5 minutes in a deep basin containing 8 to 10 gallons of potable water. All other equipment will be flushed with potable water for a period of 5 minutes.

- The bladder pump will be disassembled and the pump parts will be placed into a deep basin containing 8 to 10 gallons of non-phosphate detergent solution, such as Alconox™. All pump parts will be scrubbed with a brush.
- All bladder pump parts will be rinsed with potable water prior to reassembling the pump.
- The bladder pump will be allowed to air dry. Once dry, the bladder pump will be wrapped with aluminum foil (shiny side out) until reuse.

Between-Well Decontamination

- The bladder pump will be operated for a period of 5 minutes in a deep basin containing 8 to 10 gallons of potable water. All other equipment will be flushed with potable water for a period of 5 minutes.
 - The bladder pump will be operated for a period of 5 minutes in a deep basin containing 8 to 10 gallons of a non-phosphate detergent solution, such as Alconox™. All other equipment will be flushed with fresh detergent solution for a period of 5 minutes.
 - The bladder pump will be operated for a period of 5 minutes in a deep basin containing 8 to 10 gallons of potable water. All other equipment will be flushed with potable water for a period of 5 minutes.
 - The bladder pump will be operated in a deep basin containing distilled/deionized water to withdraw 1 to 2 gallons of final rinse water. Bladder pump decontamination (rinse) blanks of this final rinse water will be collected at a frequency of 1 per 10 investigative samples.
 - The bladder pump will be allowed to air dry. Once dry, the bladder pump will be wrapped with aluminum foil (shiny side out) until reuse.
11. The monitoring wells will be sampled in the order of least contaminated to most contaminated.
 12. The majority of the natural attenuation parameter samples collected require that preservatives be added (as noted in Tables 1 and 4). These preservatives may be added to the sample bottles by the laboratory before sampling, or may be added after sampling by field personnel (as appropriate).
 13. Additional samples may be collected [i.e., matrix spike/matrix spike duplicate (MS/MSD) samples] in accordance with the QAPP established for the Site.

14. The sampling will be conducted in accordance with the Health and Safety Plan (HSP) established for the Site.

A.3.0 REFERENCES

- Puls, R.W., and M.J. Barcelona, 1996, Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures, EPA Ground Water Issue, R.S. Kerr Environmental Research Center, Ada, Oklahoma, EPA/540/S-95/504, April.
- USEPA, 1996, Low Stress (low flow) Purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells, Region I, SOP#: GW 0001, Revision Number 2, July 30.
- USEPA, 1998, Ground Water Sampling Procedure, Low Stress (Low Flow) Purging and Sampling, Region II, Final GW Sampling SOP, March 16.

TABLE A.1
NATURAL ATTENUATION INDICATOR PARAMETERS,
PARAMETER ANALYSIS METHODS, AND PARAMETER USE IN A NATURAL ATTENUATION EVALUATION
SUMMIT NATIONAL SUPERFUND SITE
DEERFIELD, OHIO

<i>Parameter (1)</i>	<i>Analytical Method (2)</i>	<i>Detection Limit</i>	<i>Parameter Use in a Natural Attenuation Evaluation</i>
Primary Substrate (in absence of anthropogenic carbon)			
Dissolved Organic Carbon (3)	EPA - 415.1	0.1 mg/L	- used as a primary substrate (electron acceptor) for biodegradation of chlorinated solvents
Redox Indicators (in order of decreasing redox potential)			
nitrate (4)	EPA - 353.2	0.1 mg/L	- used as an electron acceptor in anaerobic biodegradation (nitrate-reducing zone)
nitrite (4)	EPA - 353.2	0.1 mg/L	- used as an electron acceptor in anaerobic biodegradation (nitrate-reducing zone)
manganese (II) (Mn^{2+}) (5)	SW-846 - 6010	0.1 mg/L	- product of anaerobic biodegradation in which manganese (IV) (Mn^{4+}) primarily present on soil particles has been reduced to manganese (II) which exists primarily in solution (manganogenic zone)
iron (II) (Fe^{2+}) (5)	SW-846 - 6010	0.1 mg/L	- product of anaerobic biodegradation in which iron (III) (Fe^{3+}) primarily present on soil particles has been reduced to iron (II) which exists primarily in solution (ferrogenic zone)
sulfate (SO_4^{2-})	EPA - 375.4	1 mg/L	- used as electron acceptor in anaerobic biodegradation (sulfidogenic zone)
sulfide (6)	EPA - 376.1	0.5 mg/L	- product of sulfate reduction during anaerobic biodegradation (sulfidogenic zone)
methane (7)	EPA RSK - 175/JSC 36 - 98	1 µg/L	- product of carbon dioxide reduction during anaerobic biodegradation (methanogenic zone)
Geochemical Indicators			
alkalinity (8)	EPA - 310.1	1 mg/L	- levels above background may indicate buffering against acids generated from biodegradation
calcium (5)	SW-846 - 6010	1 mg/L	- levels above background may indicate buffering against acids generated from biodegradation
carbonate hardness	(9)		- levels above background may indicate buffering against acids generated from biodegradation
hardness	SM 2340B	1 mg/L	- levels above background may indicate buffering against acids generated from biodegradation
magnesium (5)	SW-846 - 6010	1 mg/L	- levels above background may indicate buffering against acids generated from biodegradation
Biodegradation End Products			
chloride	EPA - 325.2	1 mg/L	- levels above background may indicate transformations of chlorinated solvents to end products
ethane (7)	EPA RSK - 175/JSC 36 - 98	1 µg/L	- levels above background may indicate transformations of chlorinated solvents to end products
ethene (7)	EPA RSK - 175/JSC 36 - 98	1 µg/L	- levels above background may indicate transformations of chlorinated solvents to end products

Notes:

- (1) With the exception of the dissolved gasses (methane, ethane, ethene), samples will be field filtered using an in-line 0.45 µm filter.
- (2) SW-846 - "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods", EPA SW-846, 3rd Edition, November 1986 with promulgated updates.
EPA - "Methods for Chemical Analysis of Water and Wastes", EPA-600/4-79-020, revised March 1983.
EPA RSK-175 - EPA internal Standard Operating Procedure dated 8/11/94 by Bryan Newell at the R.S. Kerr Laboratory in Oklahoma.
SM - "Standard Methods for the examination of Water and Wastewater", 19th Edition, 1995.
JSC 36 - 98 - Kampdell, D.H., and S.A. Vandergrift, Analysis of Dissolved Methane, Ethane, and Ethylene in Ground Water by a Standard Gas Chromatographic Technique, Journal of Chromatographic Science, 36, pp. 253-256, 1998.
- (3) Samples will be preserved with H_2SO_4 to a pH<2.
- (4) A sample (preserved with H_2SO_4 to a pH<2) is to be obtained for a nitrite and nitrate analysis. Total nitrate plus nitrite is to be determined followed by a nitrite analysis. Nitrate will be determined from the difference between these analyses.
- (5) Samples will be preserved with HNO_3 to a pH<2.
- (6) Samples will be preserved with ZnAc (laboratory will prepare sample bottle with ZnAc) and NaOH will be added to a pH>9 after sample collection by field personnel.
- (7) Samples are not to be field filtered. Samples will be preserved with HCl to a pH<2.
- (8) Both carbonate and bicarbonate alkalinity are required.
- (9) Carbonate hardness will be determined by calculation from hardness and alkalinity results.

TABLE A.2

**FIELD MEASURED PARAMETERS AND
PARAMETER USED IN LFP AND IN A NATURAL ATTENUATION EVALUATION
SUMMIT NATIONAL SUPERFUND SITE
DEERFIELD, OHIO**

<i>Parameter (1)</i>	<i>Measurement Method (2)</i>	<i>Parameter Use for LFP and for a Natural Attenuation Evaluation</i>
pH	pH meter	- the pH of stagnant well casing water may not be representative of the groundwater in the subsurface - pH is influenced by biological reactions in groundwater
temperature	temperature meter	- the temperature of stagnant well casing water may not be representative of the groundwater in the subsurface biological and chemical reactions are temperature sensitive
conductivity	conductivity meter	- the conductivity of stagnant well casing water may not be representative of the groundwater in the subsurface
Oxidation/Reduction (redox) Reaction Potential (Eh)	ORP meter	- the redox potential of stagnant well casing water may not be representative the groundwater in the subsurface - indicates the level of electron activity and the relative tendency of the groundwater to accept or transfer electrons during biodegradation
Dissolved Oxygen (DO)	DO meter	- the DO of stagnant well casing water may not be representative of the groundwater in the subsurface - sufficient DO (>1 mg/L) in groundwater indicates favourable conditions for aerobic biodegradation
turbidity	turbidity meter	- the turbidity of stagnant well casing water may not be representative of the groundwater in the subsurface

Notes:

- (1) Parameters are listed in the order that they are generally expected to stabilize while purging. Purging will be continued until each parameter has stabilized prior to sampling.
- (2) Measurement of field parameters will be obtained using a flow-through-apparatus. Measurements may be obtained using individual meters or a multiple meter unit. The meters will be calibrated each day prior to use.

TABLE A.3

Project Name: _____
Ref. No.: _____

Date: _____
Personnel: _____

Well No.: _____
Measurement Point: _____
Constructed Well Depth (ft): _____
Measured Well Depth (ft): _____
Depth of Sediment (ft): _____

Screen Length (ft): _____

Depth to Pump Intake (ft)⁽¹⁾: _____

Well Diameter, D (in): _____

Well Screen Volume, V_s (mL)⁽²⁾: _____

Depth to Water Before Placing Pump (ft): _____

Depth to Water After Placing Pump (ft): _____

[illegible]

- (1) The pump intake must be placed at the well screen mid-point or at a minimum of 2 ft above any sediment accumulated at the well bottom, which ever is more shallow.
- (2) The well screen volume is based on a 5-foot screen length, $V_s = \pi \cdot (D/2)^2 \cdot (5 \cdot 12) \cdot (2.54)^3$
- (3) The drawdown from the initial water level should not exceed 0.3 ft.
- (4) Purging will continue until stabilization is achieved or until 20 well screen volumes have been purged (unless purge water remains visually turbid and appears to be clearing, or unless stabilization parameters are varying slightly outside of the stabilization criteria and appear to be stabilizing), No. of Well Screen Volumes Purged = V_p/V_s .

TABLE A.4

**CONTAINER, PRESERVATION, SHIPPING, AND PACKAGING REQUIREMENTS FOR NATURAL ATTENUATION INDICATOR PARAMETERS
SUMMIT NATIONAL SUPERFUND SITE
DEERFIELD, OHIO**

<i>Analyses</i>	<i>Sample Containers</i>	<i>Preservation</i>	<i>Maximum Holding Time from Sample Collection (1)</i>	<i>Volume of Sample</i>	<i>Shipping</i>	<i>Normal Packaging</i>
<u>Natural Attenuation Parameters (2)</u>						
Select Metals (3)	One 1-liter polyethylene bottle	HNO ₃ to pH<2	180 days for analysis	Fill to neck of bottle	Overnight Courier or hand delivered	Bubble Wrap or Foam Chips
Alkalinity, Chloride, Nitrite, Sulfate	One 1-liter polyethylene bottle	Iced, 4 ° C	14 days for analysis 28 days for analysis 48 hours for analysis 28 days for analysis	Fill to neck of bottle	Overnight Courier or hand delivered	Bubble Pack or Foam Chips
Nitrite and Nitrate (NPN)	One 250-ml polyethylene bottle	H ₂ SO ₄ to pH<2 Iced, 4 ° C	28 days for analysis	Fill to neck of bottle	Overnight Courier or hand delivered	Bubble Pack or Foam Chips
Total Organic Carbon	Two 40-ml glass vial w/teflon lined silican septa	H ₂ SO ₄ to pH<2 Iced, 4 ° C	28 days for analysis	Fill to neck of bottle	Overnight Courier or hand delivered	Foam liner
Select Gases (4)	Two 40-ml glass vial w/teflon lined silican septa	HCl to pH<2 Iced, 4 ° C	14 days for analysis	Fill completely, no air bubbles	Overnight Courier or hand delivered	Bubble Pack or Foam Chips
Sulfide	One 250-ml polyethylene bottle	ZnAc Plus NaOH to pH<9 Iced, 4 ° C (5)	7 days for analysis	Fill to neck of bottle	Overnight Courier or hand delivered	Bubble Pack or Foam Chips

Notes:

- (1) These are technical holding times and are based on time elapsed from time of sample collection.
 (2) Natural Attenuation Parameters will require field filtering through an in-line 0.45 µm filter.
 (3) Select Metals = Manganese, Iron, Calcium, and Magnesium.
 (4) Select Gases = Methane, Ethane, and Ethene which are not to be field filtered.
 (5) Sulfide preservation will require the addition of NaOH *after sample collection*.